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Did the Federal Crop Insurance Reform Act Alter Farm Enterprise Diversification?

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Abstract

We estimate how much United States farms changed enterprise diversification in response to a marked increase in crop insurance coverage brought about by the 1994 Federal Crop Insurance Reform Act, which substantially increased insurance subsidies. The analysis exploits farm-level panel census data to compare farm-specific changes in enterprise diversification over time. By examining diversification decisions of the same farms over time, we control for time-invariant unobserved individual heterogeneity. We then use pooled cross-sectional data from the United States Department of Agriculture (USDA) Agricultural Resource Management Survey to estimate the relationship between farm diversification and average returns. We find that the insurance subsidies caused a modest increase in enterprise specialisation and production efficiency. Estimated efficiency gains are far less than the subsidies.

Keywords: *Agricultural risk management; diversification; federal crop insurance.*

JEL classifications: *Q12, Q18.*

1. Introduction

It has long been recognised that risk-averse farmers may diversify their portfolio of productive enterprises to reduce income variation. However, diversification tends to come at the cost of lower average returns. Early research into this area focused on describing optimal enterprise portfolios, accounting for the tradeoffs between risk and expected returns (Heady, 1952; Stovall, 1966; Johnson, 1967; Robison and Blake, 1979). Given the economic costs to diversification in terms of potentially

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lower average returns, a policy focused upon reducing farm income risk (e.g. crop insurance subsidies) might increase enterprise specialisation and raise production efficiency. Indeed, improving efficiency by reducing the need for farmers to use inefficient risk-coping strategies is a key economic justification for government subsidisation of crop insurance. Despite this, we are not aware of any empirical evidence of links between crop insurance policy, enterprise diversification and production efficiency. A better understanding of these links is important given subsidised crop insurance is becoming an increasingly important instrument of farm policy in the United States.

This study exploits a large exogenous increase in Federal crop insurance subsidies in order to compare changes in diversification of farms facing different changes in exposure to risk. In 1994, the US Congress passed the Federal Crop Insurance Reform Act (FCIRA), which markedly increased subsidies for premiums paid for crop insurance – fully subsidising low levels of insurance (catastrophic coverage) and partially subsidising higher levels of insurance. The increase in subsidies induced markedly greater participation in crop insurance programmes. An instrumental variables approach allows us to isolate the change in insurance coverage caused by the exogenous change in insurance subsidies, thereby enabling comparisons between changes in enterprise diversification for farms facing different exogenous changes in risk.[2] By examining changes in diversification for the same farms across time, we hold time-invariant factors associated with the operation constant and thereby control for much unobserved individual heterogeneity.

In the second part of the study we use pooled cross-sectional data from the USDA Agricultural Resource Management Survey (ARMS) to estimate the relationship between diversification and expected returns. Our results, in line with earlier results by Katchova (2005), indicate a small gain in expected returns accruing to more specialised farms. Combining these results with the estimated effects of FCIRA on specialisation, we find that the Act led to a modest increase in production efficiency.

2. Background

Farmers' decisions to diversify their portfolios of productive enterprises are probably driven by both risk and non-risk factors. As the majority of farmers did not purchase substantial levels of crop insurance prior to the Congress passing the FCIRA, operators may have diversified their enterprises to reduce income variation. After adopting insurance, many farms may have increased specialisation as their need for self-insurance declined. However, there are other non-risk reasons to diversify production on a farm. Agronomic benefits of crop rotations or the efficient utilisation of constrained capital and labour inputs may give rise to an optimal production strategy that includes multiple crops. If these non-risk factors were the

[2] Note that diversification does not generate an unambiguous mean–variance tradeoff. However, diversification is widely touted as a means to lower a farmer's variance of returns (regardless of its effect on the mean), as is crop insurance. Although these arguments logically suggest that the two are substitutes for each other, no studies have examined this question, which is what we propose to do in this paper.

main motives for diversification, we might expect little change in diversification upon passage of the FCIRA.

Although it seems reasonable to suppose that an increase in crop insurance coverage results in greater enterprise specialisation for risk-averse producers, this does not follow unambiguously from theory. Risk-averse farmers facing imperfect markets for insurance will generally diversify more than risk-neutral farmers who, in the absence of other constraints, would fully specialise in the enterprise earning the highest expected returns. For risk-averse farmers, however, an *incremental* increase in risk may either increase or decrease standard measures of enterprise diversification. This ambiguity arises mainly because standard diversification measures (reviewed below) are generic in the sense that they do not embody the full covariance matrix of return possibilities across crops.[3]

Furthermore, if financial markets are complete (or nearly so) and farmers can effectively cope with risk using savings, credit, futures markets or private insurance, then farmers may not respond to additional insurance subsidies. Even if farmers are risk-averse individuals they would behave *as if* they were risk-neutral prior to policy change.[4]

Despite the theoretical ambiguity surrounding how risk-averse farmers would alter enterprise diversification in response to a change in risk, little empirical evidence exists to inform this question. Previous studies have focused on understanding the characteristics of farms associated with varying levels of enterprise diversification, but they have not incorporated measures of farm income risk (Pope and Prescott, 1980; Mishra and El-Osta, 2002). Ballivian and Sickles (1994) estimated a cross-sectional relationship between revealed attitudes towards risk and enterprise diversification. Using data from India, the authors estimated a profit function that incorporated an index of farmer risk aversion as a quasi-fixed input factor. They found evidence that more risk-averse individuals diversified more and were willing to sacrifice lower average returns for lower profit variability. Their study provides evidence that attitudes towards risk can influence diversification decisions, but does not attempt to evaluate the effects of a policy that alters farmers' costs of managing risk.

One of the key questions from a policy perspective is whether imperfect risk sharing causes farmers to diversify more than they would in the absence of financial market imperfections (i.e. if risk sharing were perfect). From a domestic perspective, this constitutes the crux of many debates surrounding Federal crop insurance (and other government stabilisation policies) because the results tell us whether these policies at least have the potential for increasing production efficiency and welfare. From an international and trade perspective, increased specialisation may accompany possible production effects, which may distort trade even while it enhances efficiency.

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[3] Conceptually, a full-fledged portfolio analysis can solve this problem. However, obtaining meaningful estimates of the covariance matrix is not feasible, given the limited length of time-series data.

[4] By 'risk' we are referring to idiosyncratic farm production risk, not aggregate risk. Risk associated with the aggregate economy could affect production choices, even under perfect risk sharing. Aggregate risk is usually not considered explicitly in the agricultural economics literature.

3. Crop Insurance

We examine farmers' responses to the large increase in subsidies resulting from the FCIRA of 1994. FCIRA, beginning with the 1995 growing season, modified the federal crop insurance programme by authorising the USDA to offer essentially 'free' catastrophic coverage to producers growing insurable crops.[5] Catastrophic coverage indemnifies yield losses below 50% of expected yield at 55% of the expected price. FCIRA also subsidised premiums on higher 'buy-up' coverage levels. For buy-up coverage, producers pay a portion of the actuarial premium plus a small administrative fee. The share of the total premium paid by the government varies by coverage level. For example, in 1997, the typical subsidy share was 42% for the 65% buy-up coverage level.

The FCIRA had a large effect on the number of acres insured and coverage levels. This is illustrated in Figure 1, which shows total subsidies, total premiums (farmer contributions plus government subsidies), and total acres enrolled in the crop insurance programme from 1990 to 1998. The figure presents separate plots for all crops and for the three largest individual crops (in acreage): corn, soybeans and wheat. In 1997, these three crops accounted for 78.9% of the acreage insured, 55.5% of the subsidies, 51.7% of the total premiums and 53.8% of cultivated cropland (excluding hay).[6] Although mandatory participation constraints imposed in 1995 (and subsequently lifted in 1996) clearly played a role, Figure 1 strongly suggests that the bulk of the overall increase in insurance adoption stemmed directly from the increase in subsidies.[7]

Table 1 provides additional information on the FCIRA for the 10 crops that accounted for 85% of premiums paid in 1997. The table reports the 1992 and 1997 levels of premiums, acres harvested, share of acres insured, premiums per acre harvested, premiums per insured acre and subsidies per insured acre. Premiums increased for most crops between 1992 and 1997. For barley, potatoes and dry beans, premiums per acre harvested increased by about one-third; for wheat and sorghum, premiums increased by about one-half; and cotton, corn and soybean premiums increased by almost two-thirds. The most extreme cases were peanuts, which

[5] The premium on this level of coverage is fully subsidised by the government but farmers must pay a nominal per-crop, per-county administrative fee.

[6] Although many revenue insurance products became available around this time (e.g. Crop Revenue Coverage, Income Protection and Revenue Insurance plans), yield insurance remained the predominant form of crop insurance coverage over our sample. Crop insurance spiked from 99.6 million acres covered in 1994 to 182.2 million acres by 1997, which cannot be explained by the introduction of the revenue insurance contracts. More probably, the revenue contracts attracted those more likely to insure because of the lower prices of insurance (the subsidies).

[7] In 1995, crop insurance adoption became mandatory for farmers wishing to avail themselves of federal farm programmes, probably helping to fuel the increase in adoption rates of insurance seen in Figure 1 in 1995. However, this rule was lifted in 1996, with a subsequent drop in insurance coverage. Despite these changes in eligibility requirements, the overall levels of insurance remained dramatically higher post-FCIRA than their levels pre-FCIRA, suggesting that the main driver of insurance adoption stemmed from the lower crop insurance prices offered through the use of increased subsidy rates.

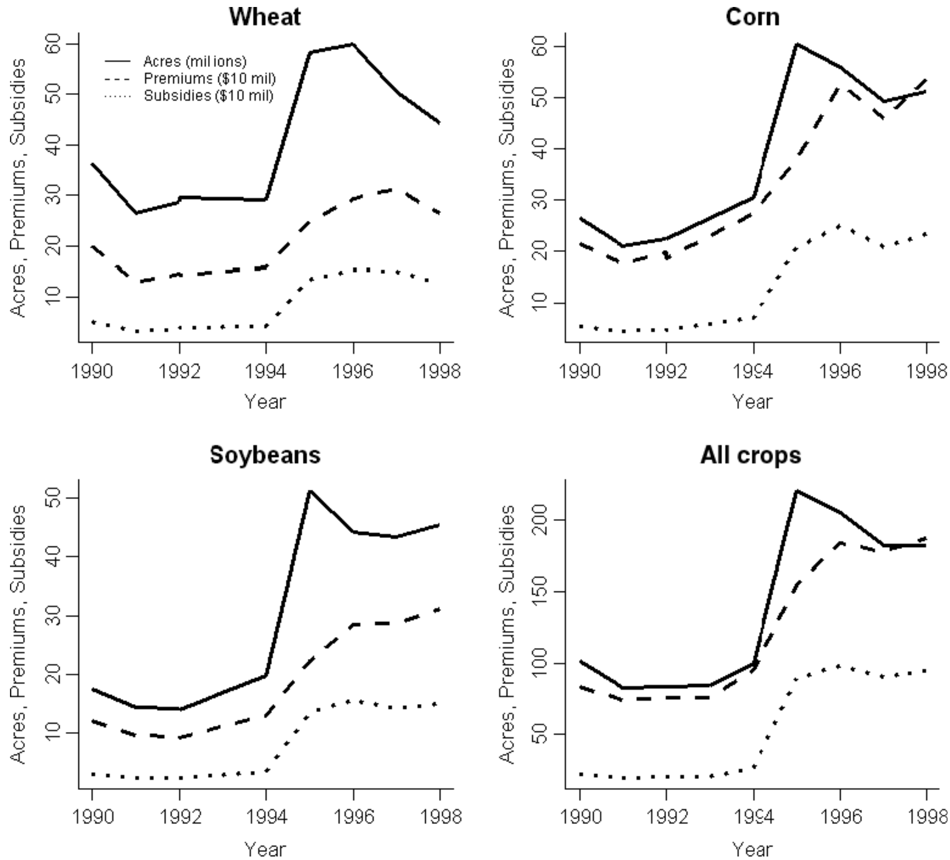

Figure 1. Insurance coverage of all crops and largest individual crops in years preceding and following the FCIRA of 1994
Source: Risk Management Agency, at http://www.rma.usda.gov/data/

showed little increase (the crop was heavily insured before the policy change), and tobacco, for which no federal crop insurance was available in 1992.

4. Methods

Our empirical analysis relates measures of diversification to insurance coverage. The hypothesis is that greater insurance coverage implies less exposure to risk and thus greater incentive to specialise in the most profitable crop (decreasing overall diversification), regardless of risk. There are two key challenges to this exercise. First, we must adequately control for factors besides risk exposure that affect diversification. Second, because insurance coverage and diversification are generally determined jointly, we need an instrument that directly affects insurance coverage and not diversification. In our case, this is provided by the introduction of FCIRA in 1994.

For producer i ($i = 1,..., N$) in time t ($t = 1992, 1997$), let D_{it} indicate a measure of diversification (candidate measures are described below). A simple pooled regression model for diversification would be:

Table 1

Insurance coverage before and after the Federal Crop Insurance Reform Act (FCIRA) of 1994

	Total premiums ($1,000)		Total acres harvested (1,000)		Share of acres insured		Average premium per acre harvested ($/acre)		Average subsidy per acre insured ($/acre)		Average premium per acre insured ($/acre)	
	1992	1997	1992	1997	1992	1997	1992	1997	1992	1997	1992	1997
Wheat	146,118	313,933	59,003	60,953	0.497	0.833	2.53	5.16	1.36	2.98	5.09	6.2
Cotton	90,657	252,676	11,742	13,787	0.371	0.835	7.86	18.36	6.22	12.84	21.21	21.98
Corn	196,412	460,662	68,905	70,371	0.327	0.702	2.87	6.55	2.23	4.18	8.78	9.34
Dry beans	13,326	25,136	1,159	1,530	0.628	0.848	11.57	16.47	5.15	9.56	18.43	19.42
Sorghum	24,974	44,788	10,336	8,351	0.351	0.755	2.45	5.38	1.96	3.59	6.98	7.13
Peanuts	39,840	36,153	1,354	1,292	0.780	0.914	29.54	28.01	8.77	13.67	37.86	30.63
Soybeans	93,715	288,374	54,672	66,135	0.262	0.659	1.74	4.37	1.69	3.29	6.62	6.63
Potatoes	12,497	28,857	905	1,107	0.326	0.626	15.91	26.52	11.68	23.55	48.73	42.35
Barley	17,486	23,708	6,463	5,893	0.474	0.763	2.78	4.06	1.55	2.61	5.86	5.32
Tobacco	0	31,768	783	806	0	0.826	0	68.66	0	31.17	0	83.15

Source: Risk Management Agency at http://www.rma.usda.gov/data/.

$$D_{it} = \alpha + \beta X_{it} + \gamma C_{it} \cdot S_{it} + \varepsilon_{it}, \tag{1}$$

where X_{it} represents a vector of farm and producer characteristics that may influence production diversification (i.e. control variables), C_{it} is the operator's per-acre crop insurance coverage (described below) and S_{it} is a vector of dummy variables indicating the scale of the operation. Interacting the coverage variable with the scale dummies allows us to estimate coverage effects separately for each of the different size classes. The error (ε_{it}) represents unobserved factors and the scalar α and vectors β and γ indicate parameters.

As we are interested in studying how crop insurance might substitute for diversification, we develop a measure of insurance coverage. Coverage is defined as total premiums, including the subsidised portion, divided by total acres of cultivable insurable crops, whether the crops were actually insured or not. Total premiums are the government's assessment of the actuarial fair value of insurance, and are thus inversely related to the farmers' exposure to risk. This measure concisely incorporates coverage related to the number of crops and acres insured and spans all types of insurance policies and coverage levels.

A simple linear regression model embodies many strong assumptions difficult to test or justify, including the linear relationship, fixed parameters, the exogeneity of the controls and coverage, and independence and constant variance of the error. These assumptions are particularly strong, given the large heterogeneity of farms. In the linear model, the inability to accurately measure important variables such as preferences and land productivity that probably influence diversification and insurance decisions in non-linear ways, raises concerns.

To remove time-invariant heterogeneity of farms and focus more squarely on exogenous coverage variation because of FCIRA, we examine changes in diversification rather than levels. The two time periods are the Agricultural Census years 1992 (pre-FCIRA) and 1997 (post-FCIRA). Because we have only two time periods, differencing is equivalent to including individual farm-fixed effects. Differencing, rather than individual farm-fixed effects, eases computation and allows us to include additional, regional fixed effects to capture unobserved time-varying factors influencing changes in diversification, which would otherwise be collinear with individual fixed effects.

Our regression model, which considers changes in diversification, is

$$\Delta D_i = \alpha + \beta X_{i0} + \gamma \Delta C_i \cdot S_{i0} + \varepsilon_i. \tag{2}$$

We use controls (X_{i0}) and size categories (S_{i0}) from the initial period (1992), because changes in these variables may be jointly determined with coverage and diversification. Note that because the equation is in differences rather than levels, except for γ, interpretations of the parameters differ from equation (1). In the following subsections, we describe our measures of diversification, coverage and control variables in detail.

4.1. Measuring diversification

We consider five measures of diversification. The first measure is simply the largest share of sales of a single commodity (including livestock) for each producer. For example, if corn made up 80% of the total sales on the farm, then the farm's first diversification measure equals 0.8.

The second measure of diversification is a Herfindahl index:

$$\text{Herfindahl Index} = \sum_i (s_i)^2 \tag{3}$$

where s_i denotes commodity i's share of total output.

Diversification can also be measured using an entropy index that ranges from 0 to 100, depending on the number of activities the firm engages in and their relative importance. For example, a firm that produces only one commodity would have an entropy measure of 0, reflecting complete specialisation. A producer who divides his efforts equally among multiple activities would receive a value of 100. One difficulty with this measure is that an operation that produces equal levels (measured by sales) of related outputs (e.g. corn and soybeans) would receive the same entropy value as would an operation that produced equal levels of unrelated outputs (e.g. barley and hogs), despite the fact that a broader range of skills, machinery, etc. would be required for the second operation than for the first.

Using the same notation as in the Herfindahl Index, the entropy measure is:

$$\text{Total entropy} = \sum_i \left\{ s_i \times \frac{\ln(1/s_i)}{\ln(n)} \times 100 \right\}. \tag{4}$$

The entropy and Herfindahl measures are highly correlated except at the extremes. The Herfindahl index is more sensitive to initial diversification levels (e.g. going from one activity to two activities produces a large change in the index while going from 10 to 11 activities produces a much smaller change) whereas the entropy measure is more sensitive to activities that have very small shares in a farm's production set. The main benefit of the entropy measure is that it can be decomposed. Theil (1972) decomposed the entropy measure into two parts: related (within group) and unrelated (between group) entropy. These two measures comprise our third and fourth measures of diversification. The decomposition of entropy can be written as:

$$\text{Related entropy} = \sum_g \left[s_g \times \sum_i \left\{ s_{i(g)} \times \frac{\ln\left(1/s_{i(g)}\right)}{\ln(n)} \right\} \right] \times 100, \tag{5}$$

where $g \in \{1, 2, ..., 7\}$ denotes the group, s_g represents the commodity groups' share of total output, $s_{i(g)}$ is commodity *i*'s share of group *g*'s output, *n* is the number of commodities (17), and ln is the natural log operator.

Using the same notation, unrelated entropy is defined as

$$\text{Unrelated entropy} = \sum_g \left\{ s_g \times \frac{\ln\left(1/s_g\right)}{\ln(n)} \right\} \times 100. \tag{6}$$

Note that total entropy is the sum of related entropy and unrelated entropy.

To construct the entropy measure using Theil's method, we grouped commodities following Jinkins (1994):

Group	Commodity
1	Barley, oats, wheat
2	Corn, soybeans, sorghum
3	Hay, miscellaneous, other crops
4	Vegetables, fruits
5	Beef, sheep, hogs, other livestock
6	Poultry
7	Dairy

4.2. Measuring insurance coverage

It is impossible to match individual-level Risk Management Agency (RMA) data with individual-level Agricultural Census data. This means that we cannot assign premiums paid or acres insured by individual farmers to farm-level data collected by the Agricultural Census. We therefore apply county-level coverage measures, on a crop-by-crop basis, to each farm according to crop acreage of each farm.[8] On the one hand, this approach has the drawback that we lose within-county variation in

[8] Using county-level averages in place of farm-specific values does not induce bias in regression analysis unless county averages are correlated with non-insurance drivers of diversification (i.e. the standard exogeneity assumption). To see this, define X^c as a matrix of county-level covariates and X as a matrix of individual values and suppose $X = X^c + u$, where u is a vector of individual deviations from the county average. Now consider the standard linear regression model: $Y = X\beta + e$, where Y is the dependent variable, β is a vector of parameters and e is the error. If we use X^c in place of X, the OLS estimate of β is $(X^{c\prime}X^c)^{-1}X^{c\prime}Y = (X^{c\prime}X^c)^{-1}X^{c\prime}(X\beta + e) = \beta(X^{c\prime}X^c)^{-1}X^{c\prime}(X^c + u) + (X^{c\prime}X^c)^{-1}X^{c\prime}e = \beta + \beta(X^{c\prime}X^c)^{-1}(X^{c\prime}u) + (X^{c\prime}X^c)^{-1}X^{c\prime}e$. By the definition of X^c, u is orthogonal to X^c, so the middle term is exactly zero. Thus, with the standard exogeneity assumption, that X^c and e are independent, the expectation of the estimate is the true β. It follows that the usual standard error calculations also apply.

insurance adoption rates for each crop, and thus lose statistical power. However, we do not lose all of this within-county variation because we do observe each farmer's crop mix and we do know insurance coverage rates for each crop in each county. Thus, even within counties, we can identify whether farms with relatively more acreage in FCIRA-subsidised crops increased their specialisation in comparison with farms with relatively less acreage in FCIRA-subsidised crops.

On the other hand, using county-level rather than farm-level measures of insurance coverage for each crop affords an ancillary benefit. At the farm level, a number of factors may cause a farm to simultaneously alter both insurance coverage and acreage allocation, creating an endogeneity problem. Using county-level coverage measures effectively instruments the farm-level change in coverage with the county-level change in coverage. This removes much of the idiosyncratic variance in the coverage variable most susceptible to endogeneity problems because broader, county-level changes are more likely attributable to the exogenous policy change.

Farm-level coverage proxies for insurance premiums per acre harvested were constructed by combining county-level crop insurance premiums obtained from the US Department of Agriculture's RMA with micro-data from the Agricultural Census. Premiums equal farmer contributions plus government subsidies.[9]

Operator *i*'s coverage per acre harvested in time *t* is defined as the weighted average premium per acre harvested for each crop in the county in which the farm is located, where the weights are given by the share of land each operator has in a particular crop:

$$C_{it} = \sum_{j} \left(P_{jt}^{c} / A_{jt}^{c} \right) s_{ijt}, \tag{7}$$

where P_{jt}^{c} is the reported total RMA premium (farmer contribution plus government subsidy) and A_{jt}^{c} is the total land harvested for crop j in the county c in which farm i is located, and s_{ijt} is the share of land that farm i has in crop j at time t. The change in coverage, ΔC_i, equals the difference in this coverage measure evaluated at 1997 and 1992, or $C_{i1} - C_{i0}$.

4.3. Instrumental variable

Although subsidies under FCIRA arguably drive most coverage growth at the county level, some may question whether simultaneity in coverage and planting decisions cause the coverage measure in (7) to remain endogenous. To address this, we instrument coverage change using an alternative measure derived from the *national* average premium per acre for each crop (P_{jt}^{N} / A_{jt}^{N}), rather than the county average (P_{jt}^{c} / A_{jt}^{c}), and distribute the coverage, as before, by multiplying by each farmer's individual crop shares (now 1992 shares only) in both periods.

[9] Note that we use total premiums, not the amount of the premium the farmer actually pays (the total premium minus the subsidy). The total premium is the correct measure because it reflects the amount of insurance coverage or total risk mitigation. See the Risk Management Agency website for details about calculating the premium for specific crops and coverage levels: http://www.rma.usda.gov/.

$$\Delta C_i = \sum_j \left(P_{j1}^N / A_{j1}^N\right) s_{ij1} - \sum_j \left(P_{j0}^N / A_{j0}^N\right) s_{ij0}. \tag{8}$$

This variable is now a function of the change in national total premiums per acre, which is driven by the exogenous policy change. Because of the high level of aggregation and the fact that we only use pre-FCIRA (1992) shares of cropland for each farmer, the use of this instrument effectively removes the idiosyncratic variability in insurance growth rates and thereby rids our model of the most probable source of endogeneity (individual insurance decisions made jointly with diversification decisions).

Multiplying equation (8) by the size variable S_{i0} creates instruments for each size grouping, which is then used in the first stage of the 2SLS regression (along with all the other exogenous variables) to create the instrumental variables ΔC_i^{IV} used in the second stage:

$$\Delta D_i = \tilde{\alpha} + \tilde{\beta} X_{i0} + \tilde{\gamma} \Delta C_i^{IV} \cdot S_{i0} + \varepsilon_i. \tag{9}$$

4.4. *Time-varying factors*

Although differencing controls for time-invariant individual heterogeneity, it does not control for variables that changed over time. It is possible that between 1992 and 1997 some variables may have changed in ways correlated with changes in insurance coverage that also altered production decisions. One major change between 1992 and 1997 was the introduction of the 1996 Federal Agricultural Improvement Reform Act (FAIR), known informally as the 'Freedom to Farm Bill'. The FAIR Act radically altered the structure of government agricultural subsidy payments by decoupling these payments from production practices and prices. Prior to the FAIR Act, to obtain programme payments, farmers had to limit current production of programme crops to a share of historical plantings to qualify for payments. The FAIR Act lifted almost all of these restrictions and thus 'decoupled' payments from production decisions and commodity price levels. Basically, the FAIR Act altered the programme supports from price contingent payments to lump-sum payments tied to land units based upon pre-FAIR Act participation in government programmes.

To control for this Act, we included as regressors the level of payments each farm received in 1997. In 1997, nearly all payments received by farmers were pre-announced payments set out by the Act [called Production Flexibility Contracts (PFCs)]. Loan deficiency payments (LDPs) and other government payments were basically non-existent due to the high commodity prices received by farmers from 1992 to 1997 (the focus of our study). Moreover, PFC payment levels were tied to historical production and participation in government programmes and thus would be closely tied to the general influence the Act would have had on the change in farmers' production decisions between 1992 and 1997. Therefore, this variable provides an indicator for the degree to which the FAIR Act would have affected the operator's production decisions and controls for any production decisions that changed as a result of the FAIR Act that could also be correlated with changes in the level of coverage.

Finally, price changes could have affected production decisions correlated with the changes in coverage. To control for price effects, we included an interaction term that weighted the previous year's prices (1991 and 1996) with the share of the commodity produced on each farm.

5. Data

Farm-level data are derived from the Agricultural Census maintained by the USDA National Agricultural Statistics Service (NASS). Census data on farm and operator characteristics are collected every five years from essentially all farms in the country. As every farm operator must respond to the survey (by law), we can track operations across time, as long as they remain in business. Each respondent receives a unique Census File Number (CFN) to track the farm, ranch or other agricultural entity controlled or operated by the individual filing the census. As the Census was established to identify how many farms exist and what they were doing, the majority of the data collected involves establishing where the farm operates and very detailed information concerning each farm's production. In addition, one-third of all farms receive a longer version of the Census survey which asks detailed questions concerning production expenses.

Merging the 1992 and 1997 censuses together by CFN resulted in a panel dataset with 2,083,171 observations. We restricted our sample of farms by Standard Industrial Classification (SIC)[10] to those who fell into the major (insurance) programme crops: namely wheat, corn, soybeans, cash grains (oilseed and grain combination farms), cotton, tobacco and Irish potatoes. This resulted in a dataset with 571,358 observations. To ensure that our sample of farms consisted of those that had the potential to be affected by the insurance market, we kept only those farms on which the major insurable crops made up at least 90% of total cropland harvested in 1992, leaving 474,843 observations. To ensure a balanced panel, we kept only those producers who had entries in both 1992 and 1997, resulting in 318,725 observations. We then deleted operations where the respondents' age did not track across time, resulting in 281,465 observations.[11] Dropping entries with missing observations left us with our final dataset consisting of 239,992 observations or 119,996 differences.

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[10] A farm's SIC is based on the commodity that generated at least 50% of its revenue. Farms that did not have a single commodity generating at least half of their revenues but that produced some combination of grains (e.g. corn, wheat, other grains) and/or oilseeds that together accounted for at least half of all revenues were included in the category 'cash grain farms'.

[11] Since the Census is required every five years, the age of the respondent should have changed by five years. However, we allow for a range of four to six years to account for potential timing issues. Some entries had the same CFN number in 1992 and 1997 but had much different ages. Perhaps someone else on the same operation filed the census and received the same CFN. Alternatively, a farm could have exited in 1992 and an entrant in 1997 might have received the same CFN. Finally, it could have been a recording error of some kind.

5.1. Independent variables

Independent variables X_{i0} included the initial (1992) size (measured by sales category)[12] and SIC code of the operation, and the age, gender and experience of the principal operator. We included state fixed effects and lagged prices of outputs (weighted by the relative importance of the crop to the operator).[13] As these effects could interact with each other we also include all the two-way interaction effects between size, prices, state fixed effects and SIC codes.

Table 2 presents summary statistics for the variables used in our analysis. In 1997, in farms in our sample an average of 544 acres of cropland was harvested, of which 527 acres were planted in the 10 programme crops (the 'insurable acres') we focus on. Approximately 29% of the operations had sales less than \$25,000 and around 12% had sales over \$250,000. Producers were evenly distributed across the nine age categories, with each including between 9% and 13% of the sample. The exception was those 'less than 35 years', which included 6% of operators. Almost 98% of the farmers were male whereas all operators averaged nearly 25 years of experience. The largest category of farms, corn farms, represented 36% of all farms whereas wheat, soybean and cash grain farms collectively comprised a little more than one-half of farms. Finally, farmers received an average of \$14.61 per acre in government payments (excluding Conservation Reserve Program payments) in 1997.

To obtain a better sense of the distribution of changes in diversification that took place between 1992 and 1997, we calculated the median and the interdecile ranges of the diversification variables for each farm size class (Table 3). Over time, the median value of diversification changed very little. However, larger changes in diversification occurred at the tails of the distributions. The larger farms, while specialising more after the adoption of FCIRA (as expected) also had a narrower distribution in the change in diversification over time. This is probably due to larger farms having more to gain from greater specialisation.

The county-level insurance data used to impute the farm-level coverage came from the USDA RMA. RMA keeps detailed information on all insurance contracts provided to farmers in the US. This dataset includes detailed information about what types of insurance was adopted, how much was adopted, how many acres were covered, the types of crops covered, the levels of premiums, subsidies, indemnities, along with other information.[14]

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[12] We experimented with different size categories – including using \$500,000 and \$1,000,000 sales categories. The results remained largely the same in both size of effect and statistical significance. These results are available upon request.

[13] We used lag prices as these prices affect current year's production decisions. We weighted these prices by each farmer's share of the commodity to control for the degree of importance the price had on the farmer's production decisions. For example, if a producer had a share of zero of corn, they would not care about the price of corn. However, if they had 75% of their output in wheat, they would care very much about the price of wheat.

[14] We use county-level insurance data because individual-level data from RMA cannot be matched with the Census data. Additionally, the county-level data from RMA is much cleaner and easier to work with than the individual-level data. We therefore imputed coverage levels to farmers on a crop-by-crop basis using the county-level data.

Table 2
Variable definitions and summary statistics

Variable name	Definition	Mean	SD
Dependent variables (diversification measures)			
ΔLargest share	Change in the largest commodity share (of total output)	0.0007	0.18
ΔHerfindahl Index	Change in the Herfindahl Index	0.01	0.21
ΔTotal entropy	Change in the total entropy	−0.05	10.40
ΔRelated entropy	Change in the related entropy (among like commodities)	0.01	7.55
ΔUnrelated entropy	Change in the unrelated entropy (among unlike commodities)	−0.07	8.12
Independent variables			
Sales < 25	% Farms with sales ($) < $25,000	0.29	–
Sales 25–100	% Farms with $25,000 < sales ($) ≤ $100,000	0.34	–
Sales 100–250	% Farms with $100,000 < sales ($) ≤ $250,000	0.25	–
Sales > 250	% Farms with sales ($) > $250,000	0.12	–
Age < 35	% Principal operators where age (years) ≤ 35	0.06	–
Age 35–40	% Principal operators where 35 < age (years) ≤ 40	0.09	–
Age 40–45	% Principal operators where 40 < age (years) ≤ 45	0.12	–
Age 45–50	% Principal operators where 45 < age (years) ≤ 50	0.13	–
Age 50–55	% Principal operators where 50 < age (years) ≤ 55	0.12	–
Age 55–60	% Principal operators where 55 < age (years) ≤ 60	0.13	–
Age 60–65	% Principal operators where 60 < age (years) ≤ 65	0.12	–
Age 65–70	% Principal operators where 65 < age (years) ≤70	0.09	–
Age > 70	% Principal operators where 70 < age (years)	0.14	–
Gender	Dummy variable = 1 if male; 0 else	0.98	–
Experience	Years of farming experience of principal operator	25.05	13.25
Wheat	SIC 111 (% farms classified as wheat farms)	0.12	–
Corn	SIC 115 (% corn farms)	0.36	–
Soybeans	SIC 116 (% soybean farms)	0.18	–
Cash grains	SIC 119 (% oilseed and grain combination farms)	0.23	–
Cotton	SIC 131 (% cotton farms)	0.04	–
Tobacco	SIC 132 (% tobacco farms)	0.07	–
Potatoes	SIC 134 (% Irish potato farms)	0.006	–
ΔCoverage per acre	Change in coverage per acre	3.73	10.98
Coverage 1997	Estimated value of crop insurance purchased per acre harvested, 1997 – see text for details	6.09	11.17
Coverage 1992	Estimated value of crop insurance purchased per acre harvested, 1992 – see text for details	2.36	4.49
Gov_pay_acre 97	Total government payments per acre harvested in 1997, excluding Conservation Reserve Program payments	14.61	56.59
Observations	Number of observations in panel	119,996	

Source: Census of Agriculture 1992 and 1997 and Risk Management Agency 1992, 1997.

Table 4 shows the average insurance coverage for farms in the sample in 1992 and 1997 by sales category. FCIRA resulted in a much larger percent increase in total insurance coverage for small farms relative to larger farms. For example, the

Table 3

Distribution of changes in diversification

	Farm size (sales)			
	< \$50,000	\$50,000–\$99,999	\$100,000–\$249,999	\$250,000 +
ΔLargest share				
Median (P50)	0.000	0.000	0.001	0.003
Interdecile range (P90–P10)	0.57	0.42	0.35	0.36
ΔHerfindahl Index				
Median (P50)	0.000	0.000	0.006	0.008
Interdecile range (P90–P10)	0.71	0.45	0.38	0.38
ΔEntropy total				
Median (P50)	0.000	0.000	0.000	0.000
Interdecile range (P90–P10)	34.14	23.14	18.18	18.6
ΔEntropy related				
Median (P50)	0.000	0.000	0.000	0.000
Interdecile range (P90–P10)	18.02	13.68	10.75	10.58
ΔEntropy unrelated				
Median (P50)	0.000	0.000	0.000	0.00
Interdecile range (P90–P10)	21.35	17.83	14.61	14.85

Source: 1992 and 1997 Census of Agriculture.

Table 4

Mean total insurance coverage by sales category and year

Sales category	1992	1997	1997–1992
Sales < \$25,000	146.40 (275.20)	550.40 (1347.10)	404.00
\$25,000 < Sales ≤ \$100,000	771.40 (990.90)	1,913.80 (2964.00)	1,142.40
\$100,000 < Sales ≤ \$250,000	1,827.10 (2003.40)	4,016.10 (4665.40)	2,189.00
Sales > \$250,000	3,771.40 (5518.60)	7,464.80 (9197.00)	3,693.40

Notes: Standard deviation in parentheses.
Source: Census of Agriculture 1992 and 1997 and Risk Management Agency 1992 and 1997.

introduction of FCIRA resulted in a 276% increase (representing a \$404 increase in total coverage) for very small firms (category 1) whereas the very large firms (category 4) experienced a growth of 98% (an increase of \$3,693.40 in total coverage). However, larger farms had a greater absolute increase in insurance coverage and hence we theorise that their risk environment was affected more by the introduction of FCIRA than was the risk environment of smaller farms. As a result, we expect the operators of larger farms to have made larger changes in their production decisions than smaller operators – either by increasing their farm's output or through specialisation.

5.2. Benefits from specialisation

To examine the gains to specialisation brought about by the introduction of FCIRA, we estimated a simple linear relationship between diversification and total farm profits. There is a lot of noise inherent in any variable of profits measured over time, making it very difficult to estimate such a relationship. We could not use Census data to measure profits because these data suffer from excessive measurement error and are only available in one year. Aggregate shocks and storage could impart large systematic differences between expected profits and profits as measured by the Census. We therefore used several years of the Agricultural Resource Management Survey (ARMS) data, a detailed annual cross-sectional survey applied to a stratified random sample of all US farms, to estimate the level of the gains to specialisation brought about by the FCIRA.

As ARMS is a repeated cross-section and not a panel, cross-sectional identification of the effect of diversification on total farm profits is necessary. However, to properly identify the effect of diversification on farm profits, we need an exogenous source of variation of diversification, which we do not have. Additionally, using fixed effects to control for unobserved variation would remove meaningful variation in diversification, making identification impossible.

Despite the infeasibility of a careful econometric approach to diversification's effect on farm profitability, we use a cross-sectional approach to obtain a first approximation of how farmers' profits associate with various levels of diversification. Although our results could suffer from omitted variable biases (typical in cross-sectional studies), it remains our only feasible approach and should give an approximation of the probable magnitude of the insurance effects that we estimated more carefully.

Agricultural Resource Management Survey is a multi-frame, multi-phase and multi-version survey designed to capture various segments of the agricultural industry in detail and is USDA's primary source of information on the financial condition, production practices, resource use and economic well-being of US farms and their households. To ensure a representative coverage of US farms, the National Agricultural Statistics Service (NASS) develops the ARMS sample from both a list frame (using USDA, IRS and commercial records) and an area frame (where land uses are classified from 11,000 geographic segments, in which all farmers in each segment who are not on the list frame are identified and included in the ARMS survey. In phase I, the farms are screened. Randomly selected farms from Phase I then get surveyed in Phase II for production practices and chemical use at the field level. Phase III draws information at the entire farm level, focusing on farm income and expenditures, finances and the farm operator household.[15] Multiple versions of the various phases exist. Version 1 includes all types of farms whereas higher numbered versions denote a particular type of farm (e.g. dairy farms, corn farms) being surveyed.

Agricultural Resource Management Survey does not collect data from the same operator/operation over time (i.e. it is not a panel), meaning we cannot use the same methodology we used with the Census data. We therefore pool data from 1996 to 2003 Phase III Version 1 surveys. We limited the types of operations to those that had at least 90% of their production in the 10 major programme crops, in exactly the same way we did when using Census data (as the definitions are identical). Our final dataset contained 17,508 observations. We could also construct the

[15] Further information on ARMS can be found at http://www.ers.usda.gov/Briefing/ARMS/.

diversification variables in the same way outlined earlier for the Census data, enabling us to have the same interpretations for our variables and allowing us to make comparisons between the results from ARMS data and those from the Census.

As we want to better understand the relationship between diversification and profitability, we used a net income variable from the detailed ARMS data. This variable subtracts total farm operation expenses from gross farm income. Total farm expenses include total cash operating expenses, an estimate of the total non-cash expenses for paid labour, and the depreciation on all farm business assets. Included in gross farm income are income from crops and livestock, net Commodity Credit Corporation (CCC) loans, and income derived from land rented out, performing custom work, government payments, and other types of farm

Table 5

Summary statistics for ARMS data

Variable name	Definition	Mean	SD
Net income	Revenues minus costs (measure of profits)	15,248	58,452
Largest share	Largest commodity share (of total output)	0.72	0.20
Herfindahl Index	Herfindahl index of commodity shares	0.66	0.23
Total entropy	Total entropy measure of commodities	17.44	12.98
Sales < 25	% Farms with Sales (\$) < \$25,000	0.34	–
Sales 25–100	% Farms with \$25,000 < Sales (\$) ≤ \$100,000	0.33	–
Sales 100–250	% Farms with \$100,000 < Sales (\$) ≤ \$250,000	0.20	–
Sales > 250	% Farms with sales (\$) > \$250,000	0.13	–
Age < 35	% Farmers where age (years) ≤ 35	0.10	–
Age 35–40	% Farmers where 35 < age (years) ≤ 40	0.10	–
Age 40–45	% Farmers where 40 < age (years) ≤ 45	0.12	–
Age 45–50	% Farmers where 45 < age (years) ≤ 50	0.14	–
Age 50–55	% Farmers where 50 < age (years) ≤ 55	0.12	–
Age 55–60	% Farmers where 55 < age (years) ≤ 60	0.11	–
Age 60–65	% Farmers where 60 < age (years) ≤ 65	0.11	–
Age 65–70	% Farmers where 65 < age (years) ≤ 70	0.09	–
Age > 70	% Farmers where 70 < age (years)	0.14	–
Wheat	% Farms where wheat is major commodity	0.11	–
Corn	% Farms where corn is major commodity	0.46	–
Soybeans	% Farms where soybeans are major commodity	0.30	–
Cash grains	% Farms where oilseed and grains are major commodity	0.04	–
Cotton	% Farms where cotton is major commodity	0.03	–
Tobacco	% Farms where tobacco is major commodity	0.05	–
Potatoes	% Farms where potatoes are major commodity	0.01	–
N	Number of observations (expanded)	1,908,996	
*N*_a	Actual number of observations	17,508	

Source: 1996–2003 Agricultural Resource Management Survey, Phase 3.

income. The measure also includes the net change in the value of inventory, the value of farm products used or consumed on the farm, and the rental value of the operator's dwelling. Summary statistics for the diversification, income and control variables used in the estimation are reported in Table 5.

6. Results

Tables 6 and 7 present estimated relationships between the change in diversification and the change in insurance coverage. Table 6 contains the results of the first stage of the instrumental variable analyses, whereas Table 7 contains the second-stage results for the various dependent variables.

The first-stage results show that the instrumental variable is highly correlated with the original, potentially endogenous variable. Second-stage results are provided for the five diversification measures. Note that the coefficients on the different diversification indices have different interpretations. The 'largest share' and Herfindahl indices decrease when diversification levels increase whereas the Entropy indices increase with an increase in diversification. Hence, we expected (and found) that the various coefficients for the two sets of specifications have opposite signs. Additionally, our results are similar across the different specifications in terms of signs and significance levels.

For all farm sizes, the regressions indicate that producers with more coverage growth in response to the FCIRA tended to have greater increases in specialisation. It is easiest to interpret results for the first diversification measure, the largest share of total output from a single commodity. For the smallest farms, a one dollar per acre change in coverage increased the share of the commodity by 0.003. This estimate indicates that the FCIRA, associated with an increase in coverage by an average of \$3.71 per acre, increased small farmers' largest shares by an average of 1%. For the largest farms, the marginal effect of coverage on the largest commodity share was 0.005, which suggests that FCIRA increased large farmers' largest shares by an average of almost 2%.

Total entropy, a measure of the total degree of specialisation on the farm, can be decomposed into related and unrelated entropy. Estimates of related entropy (column 3) are two to three times larger than those of unrelated entropy (column 4) – indicating that most of the increase in specialisation came from between-group specialisation. It appears that producers specialised by cutting back activities with little or no direct connection to their operation's main focus.[16]

The appendix contains two tables that include coefficient estimates of many of the control variables used. Among the control variables, age also factored heavily into the explanation of specialisation. Older producers increased their specialisation more than younger producers, an effect tem-

[16] We also interacted the government payments variable with individual farmer's lagged crop shares to control more thoroughly for the FAIR Act. These additional variables more carefully control for differences in how the FAIR Act affected farmers in different parts of the US based on the crops grown in those regions. None of our results changed (including parameter estimates – both sign and magnitude – and statistical significance).

Table 6
First stage: dependent variable = Δ coverage/acre

Parameter	Estimate	SE
ΔCoverage instrument × lag Sales < 25	0.88**	0.004
ΔCoverage instrument × lag Sales 25–100	0.78**	0.007
ΔCoverage instrument × lag Sales 100–250	0.90**	0.011
ΔCoverage instrument × lag Sales > 250	0.96**	0.017
R^2	0.66	
N	119,996	

Source: Census of Agriculture, 1992 and 1997 and Risk Management Agency 1992 and 1997.
Notes: **Significant at the 1% level.

pered by the operator's experience. Higher government payments were also associated with increased farm specialisation, while males specialised less than females.[17,18] Finally, note that only about 20% of the variation in the change in diversification is explained by our independent variables. Although overall this is a relatively low R^2, recall that by differencing, a lot of the variation gets removed from the variables, which tends to lower the R^2 dramatically. Under these conditions, an R^2 of around 0.20 is actually quite high.

6.1. Estimating benefits from specialisation

To estimate the benefits from increased specialisation, we regressed net income of each farm against its level of diversification (largest share of value of production of a single commodity), controlling for farm size (total farm value of production), farm specialty (based upon the commodity that makes up the farm's largest share of production), a time trend, age category of the farmer, and location [using crop

[17] Because we estimated insurance coverage for each operator using county-level coverage data, we ran a set of county-level regressions (after averaging all individual-level data within each county) to ensure that any potential measurement error did not bias our estimates. Note, however, that we lose a lot of individual-level information (e.g. we can no longer control for individual-level heterogeneity) and statistical power (we have removed within-county variation in coverage growth tied to within-county variations in crop mix). As a result, standard errors increased, reducing statistical significance for all parameter estimates. Although estimates' signs stayed the same and their magnitudes changed modestly, results remain comparable in the light of the larger standard errors. Overall, we believe our initial farm-level approach does not introduce any biases (see footnote 7 for more on this), but rather that it increases efficiency in comparison with a county-level analysis. Results are not included in the paper, but are available upon request.

[18] Finally, although we controlled for prices extensively in our regressions, to ensure that prices did not affect any of our results, we also deflated the county-level premiums by the price change between 1992 and 1997 for each commodity and reran our regressions. Results remained the same and, in the interests of brevity, were not included in the paper. The results are available upon request.

Table 7
Second stage: various measures of diversification

Parameter	(1) Δ Largest share Estimate	SE	(2) Δ Herfindahl Index Estimate	SE	(3) Δ Related entropy Estimate	SE	(4) Δ Unrelated entropy Estimate	SE	(5) Δ Total entropy Estimate	SE
$\Delta C^{IV} \times$ lag Sales < 25	0.003**	0.0001	0.004**	0.0001	–0.035**	0.005	–0.106**	0.005	–0.141**	0.006
$\Delta C^{IV} \times$ lag Sales 25–100	0.005**	0.0002	0.007**	0.0002	–0.078**	0.008	–0.212**	0.009	–0.290**	0.011
$\Delta C^{IV} \times$ lag Sales 100–250	0.005**	0.0003	0.007**	0.0003	–0.084**	0.011	–0.241**	0.012	–0.325**	0.016
$\Delta C^{IV} \times$ lag Sales > 250	0.005**	0.0004	0.006**	0.0005	–0.085**	0.016	–0.225**	0.017	–0.310**	0.022
R^2	0.215		0.201		0.186		0.217		0.205	
N					119,996					

***Source*:** Census of Agriculture 1992 and 1997 and Risk Management Agency 1992 and 1997.
***Notes*:** **Significant at the 1% level.

Table 8

Ordinary least squares regression – net income

Variable	Estimate	Standard error
Intercept	22,002.5	18,357.6
Lgshr × Sales < 25	−794.6	3,989.9
Lgshr × Sales 25–100	−3971.7	4,399.3
Lgshr × Sales 100–250	1,145.7	6,366.1
Lgshr × Sales > 250	43,061.9**	8,184.5
Sales < 25	−26,548.8**	6,187.5
Sales 25–100	−20,138.7**	5,879.0
Sales 100–250	−9,017.5	6,393.8
Age categories	Yes	
Region fixed effects	Yes	
Year trend	Yes	
R^2	0.11	
N	17,508	

Notes: **Significant at the 1% level.
Source: 1996–2003 Agricultural Resource Management Survey, Phase 3.

reporting district (CRD) fixed effects].[19] Results of this analysis are provided in Table 8.[20]

We estimate that a 1% increase in the largest share commodity of the farm was associated with an increase in the net income of farms in the largest size category by $430 – a statistically significant result. No other farm size group showed a statistically significant relationship between net income and specialisation. Within the second largest group of farms, specialisation was positively associated with net income whereas the relationship was negative for the smallest two farm-size groups.

According to the Census data, there are approximately 14,400 farms in the largest farm category that primarily produced commodity crops covered by crop insurance. Our earlier results (Table 7, column 1) indicate that the largest farms increased the share of their major commodity by an average of almost 2%. This estimate implies that crop insurance subsidies translated into an approximately 12.4 million dollar annual increase in net income for these farms.[21] Recall that we were forced to use a cross-sectional approach here, meaning we may not have been able to eliminate omitted variable biases. However, the biases would have to be very large to affect

[19] Crop reporting districts are sub-state but super-county geographic locators. They are constructed by adding several counties together. The counties tend to be lumped together by land quality and type of commodity grown.

[20] Although we do not report the results of our other measures of diversification, the results are robust across them all. The results are available upon request.

[21] Similar results hold for the other diversification measures. Using the total entropy measure, the crop insurance subsidies translated into a total of just under a three million dollar increase in net income for all the largest farms whereas the Herfindahl index generated a return of 10.7 million dollars. Recall, however, that this is a rather crude estimate and was estimated to give a feel for the order of magnitude of the effect of specialisation on profits and its relation to total subsidies and indemnities paid out.

the main results of our findings – a change of an order of magnitude of the effect of diversification on profits (in either direction) would still yield a relatively small overall effect for farmers. Therefore, although operators appear to alter the structure of their farms in response to adopting crop insurance, the benefits that accrue to them for doing so appear modest.

7. Conclusions

In recent decades, the Federal government has markedly increased subsidies for crop insurance resulting in much higher levels of coverage. Federal crop insurance subsidies increased from \$196.7 million dollars in 1992 to \$902.7 million in 1997. The programme has continued to increase and by 2003, more than 100 crops and two-thirds of all cropland were covered by a federal crop insurance contract, with subsidy payments totalling over two billion dollars and indemnity payments totaling over \$3.25 billion. Crop insurance and other risk management programmes are likely to play a larger role in the future as income support provided under traditional commodity programmes faces growing budgetary pressure and challenges under international trade rules of the World Trade Organization (USDA, 2006). As risk reduction becomes more important as a justification for Federal farm payments, it will be increasingly useful to understand the benefits and costs of these types of programmes. To our knowledge, this paper is the first to estimate the economic benefits of Federal crop insurance programmes.

Although theory remains inconclusive about the effect of crop insurance subsidies on farm enterprise diversification and income, we are not aware of any empirical studies of the relationship between these variables. To fill this gap in the literature, we used an event study to examine the effects of FCIRA on farmers' diversification decisions and income generation. The FCIRA increased crop insurance subsidy rates, which induced operators to expand their insurance coverage. We used data from the 1992 and 1997 Agricultural Census and from the RMA's records of crop insurance adoption to estimate how farm enterprise diversification responded to the reduction in risk resulting from the implementation of FCIRA. An instrumental variables approach isolated the change in insurance coverage caused solely by the policy change. The identification strategy relied upon the hypothesis that the subsidy would be valued differently, depending on the region of the country and the crop being produced.

Results indicate that, for all farm sizes considered, operators increased specialisation in response to a policy-induced increase in insurance coverage. However, the increase in specialisation was modest, even though we focused only on those farms that had the greatest likelihood of being affected by the insurance market (those who had at least 90% of their 1992 cropland in insurable crops). For the farms examined, the share of the main activity increased by only about two percentage points, which translates into an average increase of \$860 in annual net income for the largest farms. Although FCIRA helped induce farmers to adopt crop insurance, presumably providing them with a safety net in times of need, we estimate that FCIRA created efficiency gains of less than 2% of the total subsidies paid out to encourage insurance adoption by farmers and an even smaller percentage of the nearly one billion dollars in total indemnity payments paid out to farmers in 1997. Although many often cite diversification as a key risk-coping mechanism, our results suggest that the policy change embodied in FCIRA only marginally influenced farmers' crop-allocation decisions.

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Appendix 1: Stage One Results – Full Results

	Δ Coverage/acre	
Parameter	Estimate	Standard error
Intercept	−0.99	20.55
ΔCoverage instrument × lag Sales < 25	0.88**	0.004
ΔCoverage instrument × lag Sales 25–100	0.78**	0.007
ΔCoverage instrument × lag Sales 100–250	0.90**	0.011
ΔCoverage instrument × lag Sales > 250	0.96**	0.017
Lag sales < 25	−7.99	7.02
Lag sales 25–100	−4.50	6.79
Lag sales 100–250	−5.89	6.85
Age 35–40	0.03	0.10
Age 40–45	−0.02	0.10
Age 45–50	0.02	0.10
Age 50–55	0.01	0.10
Age 55–60	0.10	0.10
Age 60–65	0.06	0.11
Age 65–70	0.02	0.11
Age > 70	0.05	0.12
Sex = male	0.13	0.13
Experience	−0.004	0.002
Gov_pay_acre 97	−0.0007	0.000
All fixed effects and interaction fixed effects	Yes	
Adj. R^2	0.660	
N	119,996	

Source: Census of Agriculture, 1992 and 1997 and Risk Management Agency 1992 and 1997.
Notes: **Significant at the 1% level.
Fixed effects include: lag SIC codes; state fixed effects; and lag Price × Share of Commodity.
Interaction fixed effects include: [lag SIC] × [State]; [lag SIC] × [lag Sales];
[lag SIC] × [lag Price × Share Commodity]; [State] × [lag Price × Share Commodity];
[lag Price × Share Commodity] × [lag Price × Share Commodity]; and [State] × [lag Sales].

Appendix 2: Second Stage: Various Measures of Diversification – Full Results

Parameter	(1) ΔLargest share Estimate	SE	(2) ΔHerfindahl Index Estimate	SE	(3) ΔRelated entropy Estimate	SE	(4) ΔUnrelated entropy Estimate	SE	(5) ΔTotal entropy Estimate	SE
Intercept	1.07*	0.51	1.36*	0.60	−22.40	21.86	−34.89	23.04	−57.29	29.77
$\Delta C^{IV} \times$ lag Sales < 25	0.003**	0.0001	0.004**	0.0001	−0.03**	0.005	−0.106**	0.005	−0.141**	0.006
$\Delta C^{IV} \times$ lag Sales 25–100	0.005**	0.0002	0.007**	0.0002	−0.08**	0.008	−0.212**	0.009	−0.290**	0.011
$\Delta C^{IV} \times$ lag Sales 100–250	0.005**	0.0003	0.007**	0.0003	−0.08**	0.01	−0.241**	0.012	−0.325**	0.016
$\Delta C^{IV} \times$ lag Sales > 250	0.005**	0.0004	0.006**	0.0005	−0.09**	0.02	−0.225**	0.017	−0.310**	0.022
lag sales < 25	−0.008	0.18	−0.001	0.21	2.74	7.46	−13.17	7.87	−10.42	10.17
lag sales 25–100	−0.004	0.17	0.03	0.20	0.99	7.23	−12.47	7.62	−11.48	9.84
lag sales 100–250	0.008	0.17	0.03	0.20	1.67	7.28	−9.92	7.68	−8.26	9.92
Age 35–40	0.01**	0.003	0.02**	0.003	−0.45**	0.11	−0.35**	0.11	−0.80**	0.15
Age 40–45	0.02**	0.002	0.03**	0.003	−0.76**	0.10	−0.57**	0.11	−1.34**	0.14
Age 45–50	0.03**	0.002	0.04**	0.003	−1.02**	0.10	−0.79**	0.11	−1.81**	0.14
Age 50–55	0.04**	0.003	0.05**	0.003	−1.31**	0.11	−1.03**	0.11	−2.34**	0.14
Age 55–60	0.04**	0.003	0.05**	0.003	−1.47**	0.11	−1.08**	0.12	−2.55**	0.15
Age 60–65	0.05**	0.003	0.06**	0.003	−1.84**	0.11	−1.21**	0.12	−3.05**	0.15
Age 65–70	0.06**	0.003	0.08**	0.003	−2.29**	0.12	−1.54**	0.13	−3.82**	0.16
Age > 70	0.07**	0.003	0.08**	0.003	−2.66**	0.12	−1.55**	0.13	−4.21**	0.17
Sex = male	−0.01**	0.003	−0.01**	0.004	0.26	0.14	0.503**	0.15	0.77**	0.19
Experience	−0.001**	0.0001	−0.001**	0.0001	0.03**	0.002	0.015**	0.002	0.05**	0.003
Gov_pay_acre 97	0.0001**	0.0000	0.0001**	0.0000	−0.002**	0.0000	−0.002**	0.0000	−0.004**	0.001

Appendix 2: ***(Continued)***

Parameter	(1) ΔLargest share Estimate	(1) SE	(2) ΔHerfindahl Index Estimate	(2) SE	(3) ΔRelated entropy Estimate	(3) SE	(4) ΔUnrelated entropy Estimate	(4) SE	(5) ΔTotal entropy Estimate	(5) SE
All fixed effects and interaction fixed effects	Yes		Yes		Yes		Yes		Yes	
Adj. R^2	0.215		0.201		0.186		0.217		0.205	
N	119,996		119,996		119,996		119,996		119,996	

***Source*:** Census of Agriculture, 1992 and 1997 and Risk Management Agency 1992 and 1997.
***Notes*:** **Significant at the 1% level.
Fixed effects include: lag SIC codes; state fixed effects; lag Price × Share of Commodity.
Interaction fixed effects include: [lag SIC] × [State]; [lag SIC] × [lag Price × Share Commodity]; [lag SIC] × [lag Sales]; [State] × [lag Price × Share Commodity]; [State] × [lag Sales]; and [lag Price × Share Commodity] × [lag Price × Share Commodity].